



The Biophysics Microgravity Initiative

S. Gorti

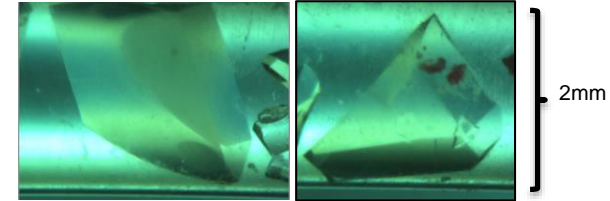


Current Biophysics Research

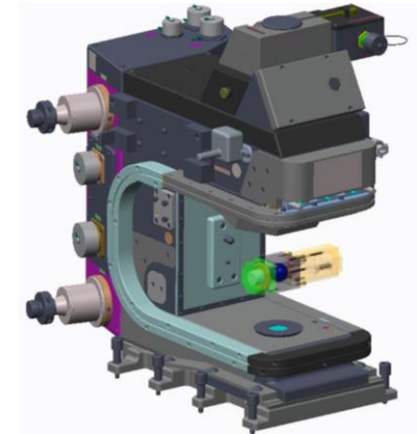


- **Macromolecular Biophysics (active)**

- Protein Crystal Growth
 - Empirically determine the beneficial effects of microgravity on the growth of large, high quality protein crystals
 - Determine the possible mechanistic means that give rise to the formation of large, high quality crystals
- Nucleation Precursors in Protein Crystallization
 - Explore the effects of solution shear flow on the nucleation of protein crystals, which may enhanced or suppressed at different rates, including its complete absence, which is only possible in microgravity environment.
- Amyloid Fibril Formation
 - Quantify the effects of flow on fibrillization in the bulk and at interfaces (air/water), which can only be performed in the microgravity environment where deleterious effects from sample walls are mitigated.



Large volume crystals grown on the ISS (>3 cubic millimeters) from the protein inorganic pyrophosphatase (IPase) from *Thermococcus thioireducens*. Prof. J. Ng, Univ. of Alabama Huntsville



Light microscopy module with the "containerless" ring shear drop assembly.



New Emphasis for Biophysics Research



- **Biomaterials**

Research solicitations had been accepted in the 2015 MaterialsLab NRA in the areas of Biological Materials, Biomaterials and/or Biomimetics. Particular emphasis to be placed on the fundamental biophysics of biofilm and scaffold formation.

- Elucidate fundamental material/cell interactions in biofilm formations and determine physical mechanisms of gravity-sensing in bacteria/fungi that leads to different formations of biofilms in microgravity.
- Gain a fundamental understanding of nucleation, growth and self-assembly of different substrates leading to the formation of 3D bio-inspired structures that can be better prepared in the absence of gravity-based effects.



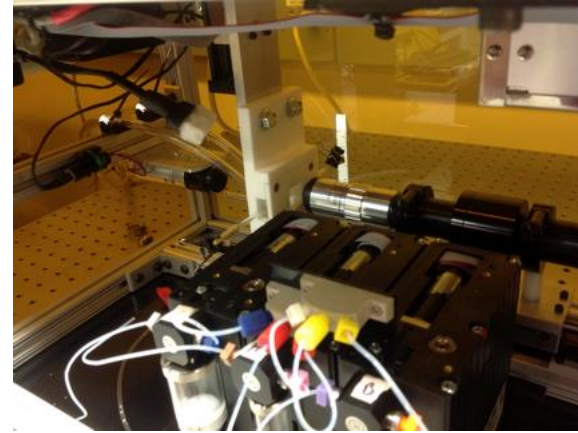
Future Plans for Biophysics Research



- **3D Bioprinting**
 - Research that investigates the principles governing self-organization of 3D bioprinted materials in microgravity aboard the ISS
 - Key themes are:
 - I. controlling cell-material interactions
 - II. controlling cell-cell interactions
 - III. controlling 3D material structure
 - Unite these themes towards technology development of tissue engineering and 3D bioprinting for long-duration spaceflight
 - Role of microgravity: understand effects of convection, gravity, and surface tension on biological systems and on materials with which they interact



Current Biophysics Research at MSFC

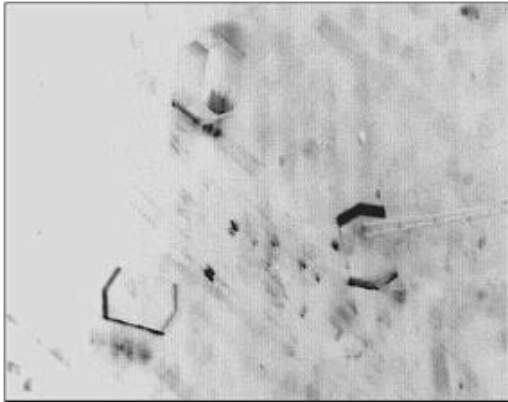


Face Growth Rate Apparatus

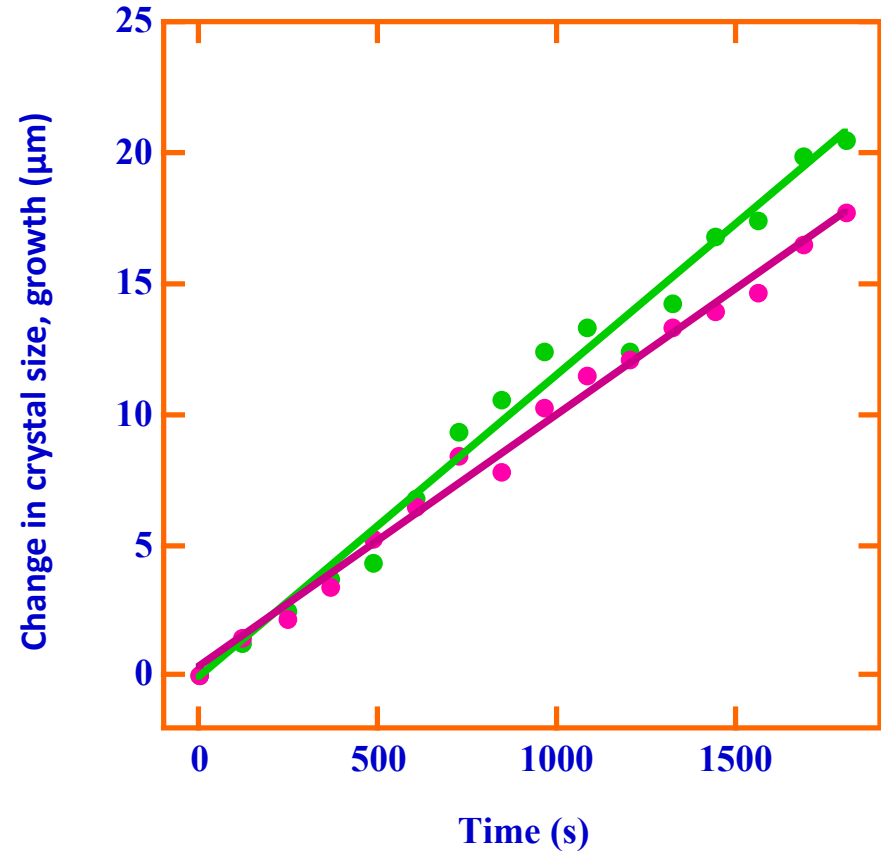
A causal relationship between modes of crystal growth and X-ray diffraction “quality” has yet to be determined.



Measurements of Growth Rates



Average growth rate $1.1 \pm 0.1 \times 10^{-6}$ cm/s





Kinetic Roughening



Crossover Supersaturation

*Lysozyme: $\sigma = 2.0 \pm 0.2$

° Glucose Isomerase: $\sigma = 5.0 \pm 0.1$

*Kinetic Roughening of Lysozyme Crystals:

S. Gorti, E.L. Forsythe & M.L. Pusey, Cryst. Growth & Design (2004) 4:691-699

S. Gorti, E.L. Forsythe & M.L. Pusey, Cryst. Growth & Design (2005) 5:473-482

S. Gorti, J. Konnert, E.L. Forsythe & M.L. Pusey, Cryst. Growth & Design (2005) 5:535-545

° Kinetic Roughening of Glucose Isomerase Crystals:

M. Sleutel, D. Maes, L. Wyns, and R. Willaert, Cryst. Growth Des., (2008) 8:4409-4414